

INTERACTION OF HYDROGEN ISOTOPES WITH CR-NI STEELS AND HIGH NI ALLOYS DURING IN CORE IRRADIATION

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The experimental results on permeability (P), diffusion (D) and solubility (S) of hydrogen isotopes (protium and deuterium, including those with oxygen and nitrogen admixtures) in Cr-Ni steels and high nickel alloys are presented. They were obtained with the usage of specially designed equipment at the IWW-2M reactor. These experiments were performed under irradiation of fast neutron flux density up to 1.8×10^{18} n/m²s and fluence up to 1×10^{25} n/m², (E>0.1 MeV) and gamma-absorbed dose rate up to 4 W/g at the temperature of 473-1200 K and hydrogen pressure ≤ 2.4 MPa.

Structural materials were tested in a protium medium under high pressure up to 130 MPa out-of-pile (in static and dynamic conditions and rupture tests) in collaboration with Institute of oil and chemistry, St. Petersburg.

The structural materials under study demonstrated general relationships and individual peculiarities. Thus, irradiation effect increased with a temperature (T) decrease. At T>673 K the Sieverts Law kept true in the first approximation and an irradiation effect on permeability was materialized owing to radiation -stimulated diffusion. The increase in P and D can reach 10-20 times and more in this case. At T<673 K there were observed weak dependencies P on T and relative growth of P under irradiation could reach several orders of magnitude. At the same time sufficient deviations of isotopic effects of P and D from their initial values, Sieverts Law and S-increase were observed. Practically complete ionization of isotopes of hydrogen –plasma condition was observed under the certain in-pile irradiation conditions. These peculiarities will be present in the interaction of the structural material with tritium.

Post-reactor materials science studies of structural materials revealed substantial changes in them under irradiation in a hydrogen medium.

At present the capabilities of the experimental reactor equipment are substantially increased at RDIPE SB. Thus, there is a possibility to irradiate SM not only by reactor emission but also by plasma of a gas discharge of hydrogen isotopes and other gases of the flow density up to 10^{23} ion/m²s (E \leq 1 keV).

Also several variants of neutron sources with E ~ 14 MeV are being developed based on a double stage conversion of reactor thermal neutrons into fast ones (in collaboration with Institute of Technical Physics, Snezhinsk). Then two estimation irradiation were jointly performed by RDIPE SB and ITP. The required information on plasma-ITER structural materials interaction can be obtained when the materials is exposed to additional neutron irradiation, E~14 MeV, and irradiation with high energy hydrogen isotopes ions up to E~191 keV.

